

WHAT IS CLAIMED IS:

1. An optical scanner comprising:
  - a plurality of light sources;
  - a coupling optical system arranged to couple beams emitted
- 5 from the light sources;
  - a line image focusing optical system arranged to focus each beam coupled to a line image extending longer in a main scan direction;
  - a deflector that has deflecting reflective surfaces on focused positions of the line image and a common rotary axis for the deflecting
- 10 reflective surfaces, is shared for all the beams from the light sources, and deflects the beams focused;
  - a scanning optical system arranged to guide the beams deflected to a plurality of target surfaces for optical scanning; and
  - a photodetector arranged to receive the beams deflected at the
- 15 deflector, wherein
  - the beams traveling toward the deflector have an open angle  $\theta$  in a deflecting rotation plane,
  - the scanning optical system includes at least two scanning lenses,
- 20 a scanning lens proximate to the target surface, out of the scanning lenses, passes only the beams traveling toward a same target surface, and
  - wherein scanning lenses proximate to the target surfaces for guiding the beams to different target surfaces have optical actions
- 25 different from each other.

2. The optical scanner according to claim 1, wherein the scanning lens proximate to the target surface has a power in a sub scan direction higher than a power in a sub scan direction of a scanning lens proximate to the deflector.

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3. The optical scanner according to claim 1, wherein the scanning optical system arranged between the deflector and the target surface for guiding the beams to different target surfaces includes a reducing optical system.

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4. The optical scanner according to claim 1, wherein the scanning lenses proximate to the target surfaces for guiding the beams to different target surfaces are arranged in different layouts.

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5. The optical scanner according to claim 1, wherein the scanning lens proximate to the target surface has a radius of sub scan curvature on at least one surface asymmetrically varying gradually from an optical axis toward both peripheries.

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6. The optical scanner according to claim 5, wherein the scanning lenses proximate to the target surfaces for guiding the beams to different target surfaces have a same shape and are rotated about an optical axis by 180 degrees oppositely from each other and arranged in different layouts.

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7. The optical scanner according to claim 1, wherein the beams emitted from at least two light sources corresponding to different target surfaces are spatially separated from each other in the deflecting rotation plane on optical paths extending from the light sources to the 5 line image focusing optical system.

8. The optical scanner according to claim 1, wherein at least two light sources corresponding to different target surfaces are integrated.

10 9. The optical scanner according to claim 1, wherein the photodetector arranged to receive the beams deflected at the deflector receives the beams corresponding to different target surfaces.

10. An optical scanner comprising:

15 a plurality of light sources;  
a coupling optical system arranged to couple beams emitted from the light sources;  
a line image focusing optical system arranged to focus each beam coupled to a line image extending longer in a main scan direction;  
20 a deflector that has deflecting reflective surfaces on focused positions of the line image and a common rotary axis for the deflecting reflective surfaces, is shared for all the beams from the light sources, and deflects the beams focused;  
a scanning optical system arranged to guide the beams deflected to a plurality of target surfaces for optical scanning; and

a photodetector arranged to receive the beams deflected at the deflector, wherein

the beams traveling toward the deflector have an open angle  $\theta$  in a deflecting rotation plane,

5 the scanning optical system includes at least two scanning lenses,

a scanning lens proximate to the deflector, out of the scanning lenses, passes only the beams traveling toward different target surfaces,

10 a scanning lens proximate to the target surface, out of the scanning lenses, passes only the beams traveling toward a same target surface, and

wherein  $P_m > 0 \geq P_s$  is satisfied, where  $P_m$  is a power of the scanning lens proximate to the deflector in the main scan direction and 15  $P_s$  is a power of the scanning lens proximate to the deflector in the sub scan direction.

11. The optical scanner according to claim 10, wherein the scanning lens proximate to the deflector has no power in the sub scan direction.

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12. The optical scanner according to claim 10, wherein the beams emitted from at least two light sources corresponding to different target surfaces are spatially separated from each other in the deflecting rotation plane on optical paths extending from the light sources to the 25 line image focusing optical system.

13. The optical scanner according to claim 10, wherein at least two light sources corresponding to different target surfaces are integrated.

14. The optical scanner according to claim 10, wherein the  
5 photodetector arranged to receive the beams deflected at the deflector receives the beams corresponding to different target surfaces.

15. An optical scanner comprising:  
a plurality of light sources;  
10 a coupling optical system arranged to couple beams emitted from the light sources;  
a line image focusing optical system arranged to focus each beam coupled to a line image extending longer in a main scan direction;  
a deflector that has deflecting reflective surfaces on focused  
15 positions of the line image and a common rotary axis for the deflecting reflective surfaces, is shared for all the beams from the light sources, and deflects the beams focused;  
a scanning optical system arranged to guide the beams deflected to a plurality of target surfaces for optical scanning; and  
20 a photodetector arranged to receive the beams deflected at the deflector, wherein  
the beams traveling toward the deflector have an open angle  $\theta$  in a deflecting rotation plane,  
the scanning optical system includes at least two scanning  
25 lenses,

a scanning lens proximate to the deflector, out of the scanning lenses, passes only the beams traveling toward different target surfaces,

- a scanning lens proximate to the target surface, out of the
- 5 scanning lenses, passes only the beams traveling toward a same target surface, and

wherein the scanning lens proximate to the target surfaces has a power in the sub scan direction higher than a power in the sub scan direction of the scanning lens proximate to the deflector.

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16. The optical scanner according to claim 15, wherein the beams emitted from at least two light sources corresponding to different target surfaces are spatially separated from each other in the deflecting rotation plane on optical paths extending from the light sources to the
- 15 line image focusing optical system.

17. The optical scanner according to claim 15, wherein at least two light sources corresponding to different target surfaces are integrated.

- 20 18. The optical scanner according to claim 15, wherein the photodetector arranged to receive the beams deflected at the deflector receives the beams corresponding to different target surfaces.

19. An optical scanner comprising:
  - a plurality of light sources;
  - a coupling optical system arranged to couple beams emitted from the light sources;
- 5 a line image focusing optical system arranged to focus the beams coupled through the coupling optical system to a line image extending longer in a main scan direction;
- 10 a deflector that has deflecting reflective surfaces in the vicinity of focused positions of the line image and arranged to deflect the beams from the line image focusing optical system; and
- 15 a plurality of scanning optical systems arranged to guide the beams deflected at the deflector to different target surfaces to form focused light spots, wherein
  - the deflector has a common rotary axis for deflecting reflective surfaces,
  - the beams entering a common deflecting reflective surface of the deflector to travel toward different target surfaces has an open angle  $\theta$  in a deflecting rotation plane,
  - 20 each of the scanning optical systems includes at least two scanning lenses and corresponding scanning lenses in the scanning optical systems are identical, and
  - 25 wherein at least one specific scanning lens in the scanning optical systems arranged to guide the beams deflected at the common deflecting reflective surface to different target surfaces is located at a position 180 degrees rotated about an optical axis from a corresponding

specific scanning lens in another scanning optical system, and  
wherein the specific scanning lens has a sub scan curvature on  
at least one surface with a shape asymmetrically varying gradually from  
an optical axis toward both peripheries in the main scan direction.

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20. The optical scanner according to claim 19, wherein the specific  
scanning lens arranged in the scanning optical systems having the  
minimum angle between an incident beam to the deflector and the  
optical axis of the scanning lens is determined to have a power in the  
10 sub scan direction at incident beam side proximate to a periphery lower  
than a power in the sub scan direction at opposite side proximate to the  
periphery.

21. The optical scanner according to claim 19, wherein at least one  
15 scanning lens other than the specific scanning lens has a sub scan  
curvature on at least one surface asymmetrically varying gradually from  
an optical axis toward both peripheries in the main scan direction.

22. The optical scanner according to claim 21, wherein the scanning  
20 lens other than the specific scanning lens is determined to have a  
power in the sub scan direction at incident beam side proximate to  
periphery higher than a power in the sub scan direction at opposite side  
proximate to the periphery.

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23. An image forming apparatus comprising  
an optical scanner that includes  
a plurality of light sources;  
a coupling optical system arranged to couple beams  
5 emitted from the light sources;  
a line image focusing optical system arranged to focus  
each beam coupled to a line image extending longer in a main scan  
direction;  
a deflector that has deflecting reflective surfaces on  
10 focused positions of the line image and a common rotary axis for the  
deflecting reflective surfaces, is shared for all the beams from the light  
sources, and deflects the beams focused;  
a scanning optical system arranged to guide the beams  
deflected to a plurality of photosensitive objects surfaces for optical  
15 scanning; and  
a photodetector arranged to receive the beams deflected  
at the deflector, wherein  
the beams traveling toward the deflector have an open angle  
θ in a deflecting rotation plane,  
20 the scanning optical system includes at least two scanning  
lenses,  
a scanning lens proximate to the photosensitive object, out of  
the scanning lenses, passes only the beams traveling toward a same  
photosensitive object, and  
25 wherein scanning lenses proximate to the photosensitive objects

for guiding the beams to different photosensitive objects have optical actions different from each other.

24. An image forming apparatus comprising
  - 5 an optical scanner that includes
    - a plurality of light sources;
    - a coupling optical system arranged to couple beams emitted from the light sources;
    - a line image focusing optical system arranged to focus 10 each beam coupled to a line image extending longer in a main scan direction;
    - a deflector that has deflecting reflective surfaces on focused positions of the line image and a common rotary axis for the deflecting reflective surfaces, is shared for all the beams from the light 15 sources, and deflects the beams focused;
    - a scanning optical system arranged to guide the beams deflected to a plurality of photosensitive objects for optical scanning; and
    - a photodetector arranged to receive the beams deflected 20 at the deflector, wherein
      - the beams traveling toward the deflector have an open angle  $\theta$  in a deflecting rotation plane,
      - the scanning optical system includes at least two scanning lenses,
  - 25 a scanning lens proximate to the deflector, out of the scanning

lenses, passes only the beams traveling toward different photosensitive objects,

a scanning lens proximate to the photosensitive object, out of the scanning lenses, passes only the beams traveling toward a same

5 photosensitive object, and

wherein  $P_m > 0 \geq P_s$  is satisfied, where  $P_m$  is a power of the scanning lens proximate to the deflector in the main scan direction and  $P_s$  is a power of the scanning lens proximate to the deflector in the sub scan direction.

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25. An image forming apparatus comprising  
an optical scanner that includes

a plurality of light sources;

a coupling optical system arranged to couple beams

15 emitted from the light sources;

a line image focusing optical system arranged to focus each beam coupled to a line image extending longer in a main scan direction;

20 a deflector that has deflecting reflective surfaces on focused positions of the line image and a common rotary axis for the deflecting reflective surfaces, is shared for all the beams from the light sources, and deflects the beams focused;

a scanning optical system arranged to guide the beams deflected to a plurality of photosensitive objects for optical scanning;

25 and

a photodetector arranged to receive the beams deflected at the deflector, wherein

the beams traveling toward the deflector have an open angle  $\theta$  in a deflecting rotation plane,

5 the scanning optical system includes at least two scanning lenses,

a scanning lens proximate to the deflector, out of the scanning lenses, passes only the beams traveling toward different photosensitive objects,

10 a scanning lens proximate to the photosensitive object, out of the scanning lenses, passes only the beams traveling toward a same photosensitive object, and

wherein the scanning lens proximate to the photosensitive objects has a power in the sub scan direction higher than a power in the 15 sub scan direction of the scanning lens proximate to the deflector.

26. An image forming apparatus for multicolor, comprising an optical scanner that includes

a plurality of light sources;

20 a coupling optical system arranged to couple beams emitted from the light sources;

a line image focusing optical system arranged to focus the beams coupled through the coupling optical system to a line image extending longer in a main scan direction;

25 a deflector that has deflecting reflective surfaces in the

vicinity of focused positions of the line image and arranged to deflect the beams from the line image focusing optical system; and

a plurality of scanning optical systems arranged to guide the beams deflected at the deflector to different photosensitive objects

5 to form focused light spots, wherein

the deflector has a common rotary axis for deflecting reflective surfaces,

the beams entering a common deflecting reflective surface of the deflector to travel toward different photosensitive objects has an

10 open angle  $\theta$  in a deflecting rotation plane,

each of the scanning optical systems includes at least two scanning lenses and corresponding scanning lenses in the scanning optical systems are identical, and

wherein at least one specific scanning lens in the scanning

15 optical systems arranged to guide the beams deflected at the common deflecting reflective surface to different photosensitive objects is located at a position 180 degrees rotated about an optical axis from a corresponding specific scanning lens in another scanning optical system, and

20 wherein the specific scanning lens has a sub scan curvature on at least one surface with a shape asymmetrically varying gradually from an optical axis toward both peripheries in the main scan direction.